

What we claim is:

1. A method for treating sleep disordered breathing comprising the steps of:

determining a patient's arousal index for use in an outer loop of a control algorithm, the arousal index being a measure of the frequency of sleep arousals,

5 monitoring the patient's respiratory airflow signal in an inner loop of said control algorithm to detect an airway obstruction,

if said arousal index is high, then increasing the sensitivity of the obstruction detection and/or the aggressiveness of the treatment, and

10 if the arousal index is low, then decreasing the sensitivity of the obstruction detection and/or the aggressiveness of the treatment.

2. A method for treating sleep disordered breathing in accordance with claim 1 wherein said arousal index is calculated from the size of the patient's breath.

3. A method for treating sleep disordered breathing in accordance with claim 2 wherein said arousal index is determined to be high by monitoring the flow rate over a sequence of breaths and checking whether the sequence is followed by a large breath.

4. A method for treating sleep disordered breathing in accordance with claim 3 wherein a patient's breath is considered to be large if it is twice as large as previous breaths.

20 5. A method for treating sleep disordered breathing in accordance with claim 1 wherein a sleep arousal is determined by a CPAP apparatus detecting a post apnea sigh or yawn.

6. A method for treating sleep disordered breathing in accordance with claim 1 wherein obstruction detection is a function of average airflow shape and the sensitivity of obstruction detection is increased by reducing the number of breaths in the average.

25 7. A method for treating sleep disordered breathing in accordance with claim 6 wherein if increasing the sensitivity of obstruction detection does not improve the patient's condition, then a threshold level necessary to increase the treatment pressure in the inner loop is adjusted to make it more sensitive.

30 8. A method for treating sleep disordered breathing in accordance with claim 1 wherein a threshold level necessary to increase the treatment pressure in the inner loop

is adjusted in order to change the sensitivity of obstruction detection.

9. A method for treating sleep disordered breathing in accordance with claim 1 wherein a time constant of decay of treatment pressure in the inner loop is increased in order to increase aggressiveness of treatment.

5        10. A method for treating sleep disordered breathing in accordance with claim 1 wherein incremental changes in treatment pressure in the inner loop are increased in order to increase aggressiveness of treatment.

10       11. A method for treating sleep disordered breathing in accordance with claim 1 wherein flow data for preceding breaths is stored and in response to a sleep arousal the data is analyzed with a threshold of greater sensitivity than the threshold previously used.

12. A method for treating sleep disordered breathing in accordance with claim 1 wherein the rate at which treatment pressure in the inner loop is increased is a function of the aggressiveness of treatment.

15       13. An apparatus for treating sleep disordered breathing comprising:

a controller for (a) determining a patient's arousal index for use in an outer loop of a control algorithm, the arousal index being a measure of the frequency of sleep arousals, and (b) monitoring the patient's respiratory airflow signal in an inner loop of said control algorithm to detect an airway obstruction, and

20       means responsive to said arousal index being high for increasing the sensitivity of the obstruction detection and/or the aggressiveness of the treatment, and responsive to said arousal index being low for decreasing the sensitivity of the obstruction detection and/or the aggressiveness of the treatment.

25       14. An apparatus for treating sleep disordered breathing in accordance with claim 13 wherein said controller calculates said arousal index from the size of the patient's breath.

30       15. An apparatus for treating sleep disordered breathing in accordance with claim 14 wherein said controller determines the arousal index to be high by monitoring the flow rate over a sequence of breaths and checking whether the sequence is followed by a large breath.

16. An apparatus for treating sleep disordered breathing in accordance with claim 15 wherein said controller considers a patient's breath to be large if it is twice as large as previous breaths.

5 17. Apparatus for treating sleep disordered breathing in accordance with claim 13 wherein said controller uses a CPAP apparatus to determine a sleep arousal by detecting a post apnea sigh or yawn.

10 18. Apparatus for treating sleep disordered breathing in accordance with claim 13 wherein said controller detects an obstruction as a function of average airflow shape and increases the sensitivity of obstruction detection by reducing the number of breaths in the average.

19. Apparatus for treating sleep disordered breathing in accordance with claim 18 wherein if increasing the sensitivity of obstruction detection does not improve the patient's condition, then the controller adjusts a threshold level necessary to increase the treatment pressure in the inner loop to make it more sensitive.

15 20. Apparatus for treating sleep disordered breathing in accordance with claim 13 wherein said controller adjusts a threshold level necessary to increase the treatment pressure in the inner loop in order to change the sensitivity of obstruction detection.

20 21. Apparatus for treating sleep disordered breathing in accordance with claim 13 wherein said controller increases a time constant of decay of treatment pressure in the inner loop in order to increase aggressiveness of treatment.

22. Apparatus for treating sleep disordered breathing in accordance with claim 13 wherein said controller increases incremental changes in treatment pressure in the inner loop in order to increase aggressiveness of treatment.

25 23. Apparatus for treating sleep disordered breathing in accordance with claim 13 further including means for storing flow data for preceding breaths and wherein in response to a sleep arousal said controller analyzes the data with a threshold of greater sensitivity than the threshold previously used.

30 24. Apparatus for treating sleep disordered breathing in accordance with claim 13 wherein the rate at which said controller increases treatment pressure in the inner loop is a function of the aggressiveness of treatment.

25. A method for monitoring and treating sleep disordered breathing by using

two control loops, one inner and one outer, wherein the inner loop is adapted to provide at least two treatment modes and the outer loop is adapted to monitor the effectiveness of therapy provided by the inner loop and to control a change in modes if necessary.

26. A method for monitoring and treating sleep disordered breathing by using  
5 two control loops in accordance with claim 25 wherein treatment modes provided by the inner loop include at least two selected from the group of basic CPAP, automatically adjusting CPAP, bi-level CPAP, and treatment of Cheyne-Stokes respiration.

27. A method for monitoring and treating sleep disordered breathing by using  
10 two control loops in accordance with claim 26 wherein the outer loop distinguishes between central and obstructive apneas, or detects oxygen desaturation events, or monitors snoring, or does two or more of these.

28. A method for monitoring and treating sleep disordered breathing by using  
15 two control loops in accordance with claim 26 wherein the outer loop determines at least two of the number of central apneas, obstructive apneas, hypopneas, and desaturation events.

29. A method for monitoring and treating sleep disordered breathing by using  
two control loops in accordance with claim 26 wherein the outer loop determines appropriate indices such as the Apnea Hypopnea Index (AHI), Central apnea Index (CI) and desaturation index (DI).

20 30. A method for monitoring and treating sleep disordered breathing by using two control loops in accordance with claim 26 wherein the outer loop monitors the intensity and severity of snoring.

31. A method for monitoring and treating sleep disordered breathing by using  
25 two control loops in accordance with claim 26 wherein the outer loop monitors flow flattening.

32. A method for monitoring and treating sleep disordered breathing by using  
two control loops in accordance with claim 25 wherein the outer loop distinguishes between central and obstructive apneas, or detects oxygen desaturation events, or monitors snoring, or does two or more of these.

30 33. A method for monitoring and treating sleep disordered breathing by using two control loops in accordance with claim 25 wherein the outer loop determines at least two of the number of central apneas, obstructive apneas, hypopneas, and desaturation

events.

34. A method for monitoring and treating sleep disordered breathing by using two control loops in accordance with claim 25 wherein the outer loop determines appropriate indices such as the Apnea Hypopnea Index (AHI), Central apnea Index (CI) and desaturation index (DI).

35. A method for monitoring and treating sleep disordered breathing by using two control loops in accordance with claim 25 wherein the outer loop monitors the intensity and severity of snoring.

36. A method for monitoring and treating sleep disordered breathing by using two control loops in accordance with claim 25 wherein the outer loop monitors flow flattening.

37. A method for monitoring and treating sleep disordered breathing by providing a set of alternative treatment algorithms, wherein indications of sleep disordered breathing are derived and an appropriate member of the set of alternative treatment algorithms is selected in accordance with said derived indications of sleep disordered breathing.

38. A method for monitoring and treating sleep disordered breathing in accordance with claim 37 wherein alternative treatment algorithms include at least two selected from the group of basic CPAP, automatically adjusting CPAP, bi-level CPAP, and treatment of Cheyne-Stokes respiration.

39. A method for monitoring and treating sleep disordered breathing in accordance with claim 38 wherein said derived indications relate to two or more of distinguishing between central and obstructive apneas, detection of oxygen desaturation events, and monitoring of snoring.

40. A method for monitoring and treating sleep disordered breathing in accordance with claim 38 wherein said derived indications relate to at least two of the number of central apneas, obstructive apneas, hypopneas, and desaturation events.

41. A method for monitoring and treating sleep disordered breathing in accordance with claim 38 wherein said derived indications are indices such as the Apnea Hypopnea Index (AHI), Central apnea Index (CI) and desaturation index (DI).

42. A method for monitoring and treating sleep disordered breathing in accordance with claim 38 wherein said derived indications relate to the intensity and severity of snoring.

5 43. A method for monitoring and treating sleep disordered breathing in accordance with claim 38 wherein at least one of said derived indications relates to flow flattening.

10 44. A method for monitoring and treating sleep disordered breathing in accordance with claim 37 wherein said derived indications relate to two or more of distinguishing between central and obstructive apneas, detection of oxygen desaturation events, and monitoring of snoring.

45. A method for monitoring and treating sleep disordered breathing in accordance with claim 37 wherein said derived indications relate to at least two of the number of central apneas, obstructive apneas, hypopneas, and desaturation events.

15 46. A method for monitoring and treating sleep disordered breathing in accordance with claim 37 wherein said derived indications are indices such as the Apnea Hypopnea Index (AHI), Central apnea Index (CI) and desaturation index (DI).

47. A method for monitoring and treating sleep disordered breathing in accordance with claim 37 wherein said derived indications relate to the intensity and severity of snoring.

20 48. A method for monitoring and treating sleep disordered breathing in accordance with claim 37 wherein at least one of said derived indications relates to flow flattening.

25 49. Apparatus for monitoring and treating sleep disordered breathing comprising an inner loop control mechanism adapted to provide at least two treatment modes, and an outer loop control mechanism adapted to monitor the effectiveness of therapy provided by the inner loop control mechanism and to control a change in mode if necessary.

30 50. Apparatus for monitoring and treating sleep disordered breathing in accordance with claim 49 wherein treatment modes provided by the inner loop control mechanism include at least two selected from the group of basic CPAP, automatically adjusting CPAP, bi-level CPAP, and treatment of Cheyne-Stokes respiration.

51. Apparatus for monitoring and treating sleep disordered breathing in

accordance with claim 49 wherein the outer loop control mechanism distinguishes between central and obstructive apneas, or detects oxygen desaturation events, or monitors snoring, or does two or more of these.

52. Apparatus for monitoring and treating sleep disordered breathing in  
5 accordance with claim 49 wherein the outer loop control mechanism determines at least two of the number of central apneas, obstructive apneas, hypopneas, and desaturation events.

53. Apparatus for monitoring and treating sleep disordered breathing in  
accordance with claim 49 wherein the outer loop control mechanism determines  
10 appropriate indices such as the Apnea Hypopnea Index (AHI), Central apnea Index (CI) and desaturation index (DI).

54. Apparatus for monitoring and treating sleep disordered breathing in  
accordance with claim 49 wherein the outer loop control mechanism monitors the  
intensity and severity of snoring.

15 55. Apparatus for monitoring and treating sleep disordered breathing in  
accordance with claim 49 wherein the outer loop control mechanism monitors flow  
flattening.

56. Apparatus for monitoring and treating sleep disordered breathing comprising  
a treatment mechanism for operating in accordance with a set of alternative treatment  
20 algorithms, and a mechanism for deriving indications of sleep disordered breathing and for selecting an appropriate member of the set of alternative treatment algorithms in  
accordance with the derived indications of sleep disordered breathing.

57. Apparatus for monitoring and treating sleep disordered breathing in  
accordance with claim 56 wherein said alternative treatment algorithms include at least  
25 two selected from the group of basic CPAP, automatically adjusting CPAP, bi-level CPAP, and treatment of Cheyne-Stokes respiration.

58. Apparatus for monitoring and treating sleep disordered breathing in  
accordance with claim 56 wherein said derived indications relate to two or more of  
distinguishing between central and obstructive apneas, detection of oxygen desaturation  
30 events, and monitoring of snoring.

59. Apparatus for monitoring and treating sleep disordered breathing in  
accordance with claim 56 wherein said derived indications relate to at least two of the

number of central apneas, obstructive apneas, hypopneas, and desaturation events.

60. Apparatus for monitoring and treating sleep disordered breathing in accordance with claim 56 wherein said derived indications are indices such as the Apnea Hypopnea Index (AHI), Central apnea Index (CI) and desaturation index (DI).

5        61. Apparatus for monitoring and treating sleep disordered breathing in accordance with claim 56 wherein said derived indications relate to the intensity and severity of snoring.

10       62. Apparatus for monitoring and treating sleep disordered breathing in accordance with claim 56 wherein at least one of said derived indications relates to flow flattening.